

available vertical sail space. System sails do so where conventional sails cannot. In summary, the System reduces to practice meaningful sail power for both recreational and commercial users where triangular sails cannot.

### CLAIMS

I claim:

21. A sail system comprising a mast, a sheet, a sail having a luff edge, a foot edge, a leech edge, a head, a tack, a clew, and means for attaching the head, tack and clew of said sail to a wind-powered vessel, such sail comprising:
  - A. a maximum foot length no greater than 100% "J";
  - B. a plurality of sail hanks;
  - C. a lower diagonal batten having a first end contained by a luff batten box having forestay connect ability attached at or near the luff of said sail at an angle of approximately ninety-degrees to said luff and a second end contained by a leech batten box attached to said sail at or near the clew of said sail, each such batten box being attached to said sail in the axis of said batten;
  - D. a batten pocket attached to said sail in the axis of said batten;
  - E. an approximately elliptical positive leech curve descending from the head of said sail through successive leech limit points to the clew of said sail, each such leech limit point deriving as follows :
    - i. said sail's head-to-clew diagonal being a line from the head to the clew of said sail;
    - ii. said sail's vertical extremities construction line being a vertical line disposed at or forward of said sail's tack and running upwards from the level of said sail's clew to the level of its head;
    - iii. said vertical extremities construction line comprising equal segments delimited by horizontal construction lines;

- iv. each such horizontal construction line running horizontally aft from said vertical extremities construction line to the companion mast of said sail;
- v. said sail's leech measurement intersections lying at respective intersections between each of said sail's horizontal leech limit construction lines and its head-to-clew diagonal;
- vi. said sail's respective forward girth segments each being equal to the horizontal distance from successive leech measurement intersections to the luff of said sail;
- vii. from uppermost to lowermost, each of said sail's aft girth segments being approximately equal in length to the following percentage of the length of respective corresponding forward girth segments: 80%, 30%, 20%, 6%, and 2%, said percentages corresponding to a preferred six-segment vertical construction line;
- viii. each of said sail's leech limit points lying along a corresponding horizontal construction line at a distance aft of the luff of said sail equal to the combined length of corresponding forward and aft girth segments;

F. said sail's leech perimeter beginning at its head and descending sequentially through successive leech limit points to terminate at said sail's clew;

whereby a low cost, hoisted, non-overlapping, self-tacking, self-boomed headsail combines semi-elliptical shape, reconciling optimum performance and optimum convenience.

22. A sail system comprising a mast, a sheet, a sail having a luff edge, a foot edge, a leech edge, a head, a tack, a clew, and means for attaching the head, tack and clew of said sail to a wind-powered vessel, such sail comprising:
- A. a maximum foot length no greater than 100% "j";
  - B. a plurality of sail hanks;
  - C. a lower diagonal batten having a first end contained by a luff batten box having forestay connect ability attached at or near the luff of said sail at an angle of approximately ninety-degrees to said luff and a second end contained by a leech batten box attached to said sail at or near the clew of said sail, each such batten box being attached to said sail in the axis of said batten;

- D. a batten pocket attached to said sail in the axis of said batten, and ;
- E. an approximately elliptical positive leech curve descending from said sail's head through successive leech limit points to the clew of said sail, each such leech limit point deriving as follows:
  - i. said sail's initial Maxjib rig contact point being a lowermost point of contact between the leech of said sail and any companion rig element;
  - ii. said sail's overlapping Maxjib rig contact diagonal being a line descending diagonally from said sail's head to its initial Maxjib rig contact point;
  - iii. said sail's vertical extremities construction line being a vertical line disposed at or forward of the sail's tack and running upwards from the level of said sail's initial Maxjib rig contact point to the head of said sail;
  - iv. said vertical construction line comprising equal segments delimited by horizontal construction lines;
  - v. each such horizontal construction line running horizontally aft from said vertical extremities construction line to the companion mast of said sail;
  - vi. said sail's leech measurement intersections lying at respective intersections between each of said sail's horizontal leech limit construction lines and its overlapping Maxjib rig contact diagonal;
  - vii. said sail's respective forward girth segments each being equal to the horizontal distance from successive leech measurement intersections to the luff of said sail;
  - viii. from uppermost to lowermost, the length of each of said sail's aft girth segments being approximately equal to the following percentage of the length of corresponding forward girth segments : 90%, b. 72%; c. 43%, d. 24%, e. 6% said percentages corresponding to a preferred six-segment vertical construction line;
  - ix. each of said sail's leech limit points lying along a horizontal construction line at a distance aft of the sail's luff equal to the combined length of corresponding forward and aft girth segments;

F. said sail's leech perimeter beginning at said sail's head and descending sequentially downwards through successive leech limit points to terminate at the clew of said sail;

whereby a low cost, hoisted, overlapping self-tacking headsail combines semi-elliptical shape and integral booming and vangging to assure optimum performance and convenience in all conditions.

23. A sail system comprising a mast, a sheet, a sail having a luff edge, a foot edge, a leech edge, a head, a tack, a clew, and means for attaching the head, tack and clew of said sail to a wind-powered vessel, each such sail comprising:
- A. a diagonal foot leading from said sail's tack upwards, forming a foot-to-leech angle of approximately ninety degrees, said foot terminating at a clew point forward of a vessel's permanent backstay or, in case of a vessel having no permanent backstay, forward of a line running from the upper extremity of the mast to the center of the aft extremity of said vessel;
  - B. a diagonally-oriented semi-rigid bottom batten approximately equal in length to the foot of said sail attached to said sail in the axis of said foot; said batten having a first end contained by a luff batten box having mast connect ability attached at or near the luff of said sail and a second end contained by a leech batten box, each such batten box being attached to said sail in the axis of said diagonal batten;
  - C. a horizontal semi-rigid batten running from a point at or near the luff of said sail at approximately the level of the clew of said sail; said horizontal batten having a first end contained by a luff batten box having mast connect ability attached at or near the luff of said sail and a second end contained by a leech batten box attached to said sail at or near the clew of said sail, each such batten box being attached to said sail in the axis of said horizontal batten;
  - D. a diagonal batten pocket attached to said sail in the axis of said bottom diagonal batten;
  - E. a horizontal batten pocket attached to said sail in the axis of said horizontal batten;
  - F. an approximately elliptical leech curve descending from said sail's head through successive leech limit points to its clew, each such leech limit point deriving as follows:
    - i. said sail's initial Maxmain rig contact point being a lowermost point of contact between the leech of the sail and a companion permanent backstay .;

- ii. said sail's backstay contact diagonal being a descending diagonal line from the head of said sail to its initial Maxmain rig contact point;
- iii. said sail's vertical extremities construction line being a vertical line disposed at or forward of the tack of said sail and running upwards from the level of initial Maxmain contact point to the level the head of said sail;
- iv. said vertical extremities construction line comprising equal segments delimited by horizontal leech limit construction lines;
- v. each such horizontal leech limit construction line running horizontally aft from said vertical extremities construction line to a point just aft of approximately ten centimeters aft of the clew of said sail;
- vi. said sail's respective leech measurement intersections lying successively at the intersection between each of said sail's horizontal leech point construction lines and said sail's backstay contact diagonal;
- vii. said sail's respective forward girth segments each being equal to the horizontal distance from successive leech measurement intersections to the luff of said sail;
- viii. from uppermost to lowermost, the length of each of said sail's aft girth segments being approximately equal to the following percentage of the length of corresponding forward girth segments: 90%, b. 72%; c. 43%, d. 24%, e. 6% said percentages corresponding to a preferred six-segment vertical construction line;
- ix. each of said sail's leech limit points lying along a corresponding horizontal leech limit construction line at a distance aft of said sail's luff equal to the combined length of corresponding forward and aft girth segments;

3. said sail's leech perimeter beginning at its head and descending sequentially downwards through successive leech limit points to terminate at the clew of said sail;

whereby a self-boomed, hoisted, semi-elliptical, mainsail assures greater economy, safety, convenience, and performance than boomed or furling mainsail configurations.

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24. The sail system of claim 1, with the following distinguishing or additional features:

a headboard-end plate combination constructed of rigid or semi-rigid light and radar reflective material comprising headboard plates with one or more pairs of integral or mechanically attached port and starboard end plates, each such port or starboard end plate being disposed at an angle of ninety-degrees relative to a corresponding port or starboard headboard plate, the upper extremity of said combination being attached to said sail at a point level with the upper extremity of said sail;

whereby a new, unexpected combination produces a synergism that enhances non-overlapping headsail performance and safety while optimizing inter-sail interface.

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25. The sail system of claim 2, with the following distinguishing or additional features:

a headboard-end plate combination constructed of rigid or semi-rigid light and radar reflective material comprising headboard plates with one or more pairs of integral or mechanically attached port and starboard end plates, each such port or starboard end plate being disposed at an angle of ninety-degrees relative to a corresponding port or starboard headboard plate, the upper extremity of said combination being attached to said sail at a point approximately level with the upper extremity of said sail;

whereby a new, unexpected combination produces a synergism that enhances overlapping headsail performance and safety while optimizing inter-sail interface.

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26. The sail system of claim 3, with the following distinguishing or additional features:

a headboard-end plate combination constructed of rigid or semi-rigid light and radar reflective material comprising headboard plates with one or more pairs of integral or mechanically attached port and starboard end plates, each such port or starboard end plate being disposed at an angle of ninety-degrees relative to a corresponding port or starboard headboard plate, said combination being attached to said sail at a point approximately level with the upper extremity of said sail;

whereby a new, unexpected combination produces a synergism that enhances mainsail performance and safety while optimizing inter-sail interface.

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27. The sail System of claim 6 with the following distinguishing or additional properties:

- A. the sail's foot being connected to an external, mast-mounted rigid spar; and
- B. a plurality of exclusively horizontal battens ;

whereby predetermined maximum roach parameters unexpectedly assure universal compatibility of overlapping, boomed mainsails with the rig elements and geometry of conventionally rigged sailboat;

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28. The sail system of claim 1 with the following distinguishing or additional properties:

- A. one or a plurality of external batten reduction combinations, each such external batten reduction combination comprising a high-density batten sleeve and a companion semi-rigid batten;
- B. each such high-density batten sleeve being constructed of sail cloth composed of diagonal or vertical fibers and horizontal fibers, such fibers having a reference density ratio of approximately two diagonal or vertical fibers to one horizontal fiber;
- C. each such high-density batten sleeve having one or more variable density zones proximate to rig contact and sail folding points in which zones diagonal or vertical fiber density is reduced by fifteen-percent and horizontal fiber density is reduced by thirty-percent;
- D. each such semi-rigid batten having one or more variable density batten zones proximate to rig contact points in which zones batten rigidity is reduced by fifteen-percent;
- E. each such external batten reduction combination having a collective rigidity level approximately equal to that of the collective rigidity level of the respective batten and batten pocket it replaces;

whereby lighter external batten reduction configurations enable foldable self-boomed, self-tacking non-overlapping hoisted headsails that reconcile optimum performance and convenience.

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29. The sail system of claim 1 with the following distinguishing or additional properties:

- A. one or a plurality of integral batten substitutes, each such integral batten substitute comprising a combination of diagonal or vertical fibers and horizontal fibers mechanically or chemically integrated with the body of the sail in the axis of a replacement batten and batten pocket;
- B. said fibers having a reference density ratio of approximately two diagonal or vertical fibers to one horizontal fiber;
- C. each such integral batten substitute having one or more variable density zones proximate to rig contact points and sail folding points in which zones diagonal or vertical fiber density is reduced by fifteen-percent and horizontal fiber density is reduced by thirty-percent;
- D. each such integral batten substitute having a collective rigidity level approximately equal to that of the batten and batten pocket it replaces;

thereby a new use of existing fiber-orientation-sail-making-technology yields batten-free self-tacking, self-boomed, non-overlapping semi-elliptical hoisted headsails with self-supported positive roach.

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30. The sail system of claim 2 with the following distinguishing or additional properties:

- A. one or a plurality of external batten reduction combinations, each such external batten reduction combination comprising a high-density batten sleeve and a companion semi-rigid batten;
- B. each such high-density batten sleeve being constructed of sail cloth composed of diagonal or vertical fibers and horizontal fibers, such fibers having a reference density ratio of approximately two vertical or diagonal fibers to one horizontal fiber;
- C. each such high-density batten sleeve having one or more variable density zones proximate to rig contact and sail folding points in which zones vertical or diagonal fiber density is reduced by fifteen-percent, and horizontal fiber density is reduced by thirty-percent;



- D. each such semi-rigid batten having one or more variable density batten zones proximate to rig contact points in which zones batten rigidity is reduced by fifteen-percent;
- E. each such external batten reduction combination having a collective rigidity level approximately equal to that of the collective rigidity level of the respective batten and batten pocket it replaces;

whereby external batten reduction configurations enable overlapping, self-tacking, self-boomed hoisted headsails that optimize tacking and jibing.

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31. The sail system of claim 2 with the following distinguishing or additional properties:

- A. one or a plurality of integral batten substitutes, each such integral batten substitute comprising a combination of diagonal or vertical fibers and horizontal fibers mechanically or chemically integrated with the sail in the axis of a replaced batten and batten pocket;
- B. said combination of fibers having a density ratio of approximately two diagonal or vertical fibers to one horizontal fiber;
- C. each such integral batten substitute having one or more variable density zones proximate to rig contact points and sail folding points in which zones diagonal or vertical fiber density is reduced by fifteen-percent, and horizontal fiber density is reduced by thirty-percent;
- D. each such integral batten substitute having a collective rigidity level approximately equal to that of the batten and batten pocket it replaces;

whereby a new use of existing fiber-orientation sail making technology yields batten-free, overlapping, semi-elliptical hoisted headsails having self-supported positive roach.

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32. The sail system of claim 3 with the following distinguishing or additional properties:

- A. one or a plurality of external batten reduction combinations, each such external batten reduction combination comprising a high-density batten sleeve and a companion semi-rigid batten;

- B. each such high-density batten sleeve being constructed of sail cloth composed of diagonal or vertical fibers and horizontal fibers, such fibers having a reference density ratio of approximately two diagonal or vertical fibers to one horizontal fiber;
- C. each such high-density batten sleeve having one or more variable density zones proximate to rig contact and sail folding points in which zones diagonal or vertical fiber density is reduced by fifteen-percent and horizontal fiber density is reduced by thirty-percent.
- D. each such semi-rigid batten having one or more variable density batten zones proximate to rig contact points in which zones batten rigidity is reduced by fifteen-percent;
- E. each such external batten reduction combination having a collective rigidity level approximately equal to that of the collective rigidity level of the respective batten and batten pocket it replaces;

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33. The sail system of claim 8 with the follow distinguishing or additional properties:

- A. one or a plurality of integral batten substitutes, each such integral batten substitute comprising a combination of diagonal or vertical fibers and horizontal fibers mechanically or chemically integrated with the sail in the axis of a replaced batten and batten pocket;
- B. said fibers having a density ratio of approximately two diagonal or vertical fibers to one horizontal fiber;
- C. each such integral batten substitute having one or more variable density zones proximate to rig contact points and sail folding points in which zones vertical or diagonal fiber density is reduced by fifteen-percent; and horizontal fiber density is reduced by thirty-percent;
- D. each such batten substitute having a collective rigidity level approximately equal to that of the batten and batten pocket elements it replaces;

whereby a new use of existing fiber-orientation-sail-making-technology yields batten-free, overlapping semi-elliptical hoisted mainsails with self-supported positive roach.

34. The sail system of claim 1, with the following distinguishing or additional properties:

- A. a plurality of battens;
- B. a topping lift;
- C. a downhaul;
- D. a single-line reefing system comprising cordage, pulleys and fairleads;
- E. a deployment control configuration comprising a plurality of control lines; a first end of each such control line being attached equidistantly along the foot of said sail; a second end of each such control line passing upwards through fairleads attached equidistantly to said sail along a corresponding axis parallel to the luff of said sail; each such control line exiting said sail approximately five centimeters from its luff then connecting to the sail's topping lift;

whereby a non-overlapping, self-tacking, self-boomed hoisted headsail combines maximum-area-semi-elliptical shape with comprehensive cockpit sail control.

35. The sail system of claim 2, wherein the sail integrates the following distinguishing or additional features:

- A. a plurality of battens;
- B. a topping lift;
- C. a downhaul;
- D. a single-line reefing system comprising cordage, pulleys and fairleads;
- E. a deployment control configuration comprising a plurality of control lines; a first end of each such control line being attached equidistantly along the foot of said sail; a second end of each such control line passing upwards through fairleads attached equidistantly to said sail along a corresponding axis parallel to the luff of said sail; each such control line exiting said sail approximately five centimeters from its luff then connecting to the sail's topping lift;

whereby an overlapping, self-tacking, self-boomed hoisted headsail combines maximum-area-semi-elliptical shape with comprehensive cockpit sail control.

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36. The sail system of claim 3, with the following distinguishing or additional properties:

- A. a plurality of battens;
- B. a topping lift;
- C. a downhaul;
- D. a single-line reefing system comprising cordage, pulleys and fairleads;
- A. E. a deployment control configuration comprising a plurality of control lines; a first end of each such control line being attached equidistantly above the foot of said sail along a horizontal axis between the clew and luff of said sail; a second end of each such control line passing upwards through fairleads attached equidistantly to said sail along a corresponding axis parallel to the luff of said sail; each such control line exiting said sail approximately five centimeters from its luff then connecting to the sail's topping lift;

whereby an overlapping, self-boomed holsted mainsail combines maximum-area-semi-elliptical shape with comprehensive cockpit sail control.